COMPARISON OF WIND AND SOLAR GLOBAL WARMING BENEFITS TO BIOMASS UNDER THE APRIL 2012 DOER REGULATIONS

Analysis by Peter Bos – May 29, 2012

Summary

An extension of the Manomet science to analyze the GHG benefits of a representative biomass power plant forest and non-forest fuel mix shows that electric-only biomass will provide GHG benefits at least as great or greater than wind or solar under the GHG Analysis Guideline 20-year Life Cycle Analysis called for in the April 2012 proposed biomass regulations.

The analysis presented in this document is based on the DOER April 2012 proposed final regulations specifying new biomass REC-qualification requirements for the MA RPS Program. The analysis is an extension of the Manomet science upon which the regulations are based. It examines the benefits of using a viable mix (eligible under the new regulations) of biomass thinnings and residuals (forest and non-forest waste wood) as fuel, and concludes that all-electric biomass power generated by this fuel will produce GHG benefits greater than wind or solar within 20 years. Importantly, the assumptions used are conservative overall, and the implications for state global warming and renewable energy policy action are significant.

The perspective from which to view the findings is critical. While there is a range of issues that concern biomass power opponents (e.g., GHG benefits, forestry practices, emissions controls, water withdrawal limits), the major factor that drove the changes in biomass REC qualification was the GHG impact of a biomass plant – hence the "50-percent of gas-fired GHG impact" qualification threshold. While unnecessary, this factor can still be the one that dictates any energy and global warming legislative and policy changes regarding biomass power REC qualification. Other environmental issues of concern should be addressed in their own arenas (e.g., DEP and other agencies). This rationale is supported by the July 7, 2010 letter from Secretary Ian Bowles in which he focused on the Global Warming Solutions Act and the need to properly incentivize biomass to achieve its goals. Further, this rationale was strongly endorsed by concerned biomass opponents, who played a major role in framing the content of the letter.

The Manomet Study that led to the new regulations addressed biomass sustainability and carbon policy. Whereas in its 2010 study Manomet examined the use of ***forest*** biomass that involved substantial cutting of live trees (with its negative GHG impacts), we examined the typical biomass plant combustion of forest ***and non-forest*** biomass with its much more positive GHG profile. Manomet, in its report introduction and also in Chapter 6 of the report, stated that waste wood fuel (residuals) has much different and likely more favorable GHG characteristics than the forest biomass fuel (including substantial live tree cutting) in the scenarios the report focused on. We have conducted a more detailed analysis, one that confirms Manomet's suggestion that biomass residuals can have more favorable GHG profiles.

The policy question posed is how to stimulate biomass power (with its significant burning of residuals) in light of the April 2012 proposed final regulations that would rule out all-electric biomass and all CHP biomass that will be unable to achieve the required efficiency under the regulations (probably most of the CHP potential). A related policy question of what REC-qualification time frame optimizes the 2050 GHG benefits under the GWSA is discussed in the analysis that follows.

Importantly, based on our analysis there is an opportunity for all parties at interest in biomass to find and agree on a biomass power alternative that meets the interests of all parties. DOER, in its April 2012 regulations summary, stated that throughout the regulatory process it has stayed steadfast in its *goal to provide the best science-based solution to support biomass energy*. Biomass opponents also support that goal. Our analysis supports that goal, and we hope that all parties will examine it closely.

Background Discussion

Manomet's GHG accounting framework (the Manomet science) underlies DOER's April 2012 biomass regulations. The GHG benefits calculation science has been endorsed by biomass opponents as valid, and by me as a biomass project developer since the report was issued

> Note: I do not advocate the wholesale cutting of live trees assumed in most Manomet study scenarios. More relevant is the Manomet conclusion on page 110 of the study that biomass plants that burn tops and limbs (residuals) would produce favorable GHG benefits comparable to all fossil power, even gas-fired power. There has been a widespread lack of understanding of this key conclusion, and there is a need for a related in-depth analysis.

I support the April 2012 regulations in principle except for:

- Several forest management limitations and administrative requirements (which I will leave to qualified foresters to address)

- The adverse effects from the efficiency requirement because it will:

    - Preclude virtually all biomass from qualifying for RECs, and thus effectively preclude eligibility for a long-term PPA.

      Note: While perhaps not intended, the smaller the biomass plant the more it will be penalized under the proposed regulations because of the (1) lower design efficiencies of the lower-pressure/temperature, smaller biomass plants that many communities want to develop, and (2) the technical and weather limitations of space heating applications (the main thermal heat option for small biomass) that preclude adding 30 percent to the plant efficiency in order to qualify for RECs. Only the larger, more efficient higher-pressure/temperature biomass plants would have the steam supply capacity to supply the year-round 24/7 thermal demand of an industrial steam user that would allow an overall 50-percent efficiency.

- Rule out a very substantial and sustainable source of biomass GHG benefits in the long term (perhaps 5 percent of the 2050 GWSA annual goal)

Note: Manomet did not recommend a minimum efficiency standard in its report.

The negative implications of retaining the efficiency requirement as structured warrant a critical examination. I do not oppose the GHG reduction requirement in the regulations. But having both the GHG reduction and efficiency requirements is unnecessary, as both have the same goal – assuring minimum GHG benefits. For reference, see the July 7, 2010 Bowles letter and subsequent DOER explanations of the revised regulations). The required GHG benefits threshold requirement obviates the need for the efficiency requirement. What is crucial to recognize is that the efficiency requirement, in fact, **will reduce GHG benefits** that could otherwise occur from all-electric and lower efficiency CHP biomass plants **that achieve the desired GHG reductions**. In fact, under the proposed regulations the benefits of an all-electric biomass project burning a typical biomass fuel mix will equal or exceed that of wind and solar. *To prohibit these projects was never intended by the Bowles July 2010 letter or the draft regulations*.

Note: The Bowles July 2010 letter did not suggest changing air, water and other environmental regulations, given that current air quality, water quality and other similar regulations assure environmental health and safety. The biomass opponents who worked with Secretary Bowles to frame the July 2010 regulations guidance letter also did not advocate imposing new environmental quality requirements in order for a biomass plant to qualify for RECs.

What exacerbates the potential impact of the efficiency requirement is that biomass power that achieves the GHG benefits represents not only a very large potential contributor to the 2050 GWSA GHG reduction goal, but also a renewable energy alternative that would have the most significant job creation impact and economic benefits – by an order of magnitude compared to the same MW capacity of wind or solar. This should not be allowed to happen for projects that are supported by the Manomet science, but whose benefits have not been either understood or recognized by policy-makers.

In summary, to support the green economy goals of Massachusetts all biomass that meets the GHG benefits requirement of the regulations should be stimulated, subject of course to all other environmental permitting requirements. This will markedly add to the job-creation momentum that has been established in the state's clean energy sector.

Note: Beyond the major job and tax benefits there are some very specific economic and social benefits that biomass can provide. One example of those – proposed a few months ago to the Town of Russell - is to utilize a western MA rail line to deliver the wood fuel, thereby reducing the exhaust emissions that would otherwise occur from the fuel-delivery trucks while supporting the Pioneer Valley Railroad. Another is the replacement at no cost of older wood stoves in Russell – an initiative that would actually *reduce* the local particulate (PM2.5), CO and black carbon concentrations. This is an innovative initiative not previously offered by any biomass project sponsor.

There is no alternative that would tie together better the benefits of renewable energy, the environment and the economy than the GHG-qualifying biomass described above.

To return to the purpose of the proposed regulations, the huge potential for biomass GHG benefits from the burning of a realistic biomass fuel mix, which includes a significant portion of residuals, has not been understood to date by any party involved in the biomass debate. Specifically:

- With a typical fuel mix including residuals biomass GHG benefits will be **at least at great *if not greater than*** wind and solar within 20 years

- Within a 40-year and greater time frame biomass GHG benefits will be ***more than twice that*** of wind or solar

One of the most significant potential contributors to the 2050 CO2 reduction goal of the Global Warming Solutions Act (GWSA) will be lost if this biomass power source is lost.

Importantly, there is an opportunity for all parties at interest to agree on the development of at least some biomass power.

- As pointed out earlier, concerned biomass opponents support the April 2012 DOER regulations and have strongly endorsed the Manomet science behind the GHG benefits analysis – a science I have extended in this analysis.

- It is first critical to understand the GHG characteristics of each component of a biomass power plant fuel mix:

1 Thinnings (low-grade trees that are cut to enhance the health and yield of a woodlands stand)

2 Forest residuals (e.g., tops and limbs) that result from normal logging and other woodlands management operations

3 Non-forest residuals or waste wood from various sources (see the Attachment listing wood waste sources).

The 2010 Manomet study focused on the first component, which has the longest-term CO2 recovery benefits. Manomet carried out a limited analysis of the second component and concluded, based on avoided CO2 emissions benefits, that this fuel would provide GHG benefits superior to gas-fired power. Manomet did not analyze the third component, which has avoided CO2 emissions benefits similar to forest residuals, but also provides avoided methane emissions benefits. The benefits from non-forest residuals are important because their methane emissions have a GHG impact of anywhere from 25 to 100 times that of CO2, depending on the time frame considered for the impacts – the shorter the time frame the greater the methane GHG impact.

- While there are benefits from burning any type of biomass fuel there is an issue with biomass opponents about the amount of forest biomass available, and they question how much biomass power can be supported by forest biomass only. There has been little discussion about the amount of non-forest residuals available for fuel, so for this analysis it is useful to temporarily remove the forest biomass availability issue from the debate over whether a meaningful amount of biomass power potential exists.

  Note: Not understood by many interested parties is the amount of Massachusetts forest wood currently supplied to operating biomass plants. One study determined that, in 2009, 340,000 tons of woody biomass from Massachusetts was supplied to biomass plants in NH and MA without any meaningful draw from western Massachusetts (the most forested part of the state).

  - A key question addressed in this analysis is what are the benefits of biomass power when clean, non-forest residuals (waste wood) are added into the picture as the fuel?

  - For some, the fuel supply issue is how much clean, non-forest wood waste is generated annually in southern New England and nearby areas. This is important because:

    - Burning this wood fuel source is consistent with the opponents' argument that, when trees are burned for energy, it should be done in a way that also protects our forests.

    - For the non-forest residuals fuel component (1) the opponents' concern about cutting down forests to fuel biomass plants is eliminated, and (2) the net biomass GHG impact is very favorable compared to any fossil fuel power source

  Woody biomass resource studies have indicated that over 2 million tons per year of non-forest waste wood are generated in southern New England, not including storm- or fire-damaged trees. Clearly, the number is not zero, and some biomass capacity is warranted using this source as part of the fuel mix.

  Note: See the attached list of waste wood sources. Included in this list are storm- and fire-damaged trees, a source of significant volume. For example, the 2011 tornado flattened almost 10,000 acres in Massachusetts, resulting in the need to remove over 500,000 tons of wood. This is just one source of waste wood. A 40-50 MW biomass plant would burn 500,000 tons per year.

  - Further, it is the biomass project sponsor who is at risk to verify these fuel sources under the very strict DOER fuel source documentation requirements

Summary of GHG Benefits Analysis of Representative Biomass Fuel Mix

Solar, wind and biomass facilities with the same annual output of 800,000 mWh per year were analyzed. Because of different annual capacity factors the rated capacities of these facilities are:

- 609 MW Solar
- 261 MW Wind
- 101 MW Biomass

The biomass GHG benefits were based on an all-electric plant only with a fuel mix eligible under the April 2012 regulations of:

- 10% thinnings
- 40% forest residuals
- 50% non-forest residuals

Note: The April 2012 regulations as proposed place restrictions on the amount of forest biomass that can be harvested, and serve to push the fuel mix toward a greater non-forest residuals content. This regulatory restriction serves to increase the GHG benefits because of the greater amount of methane emissions that will be avoided.

The fundamental concept of the net biomass GHG benefits analysis is:

> The CO2 emissions from biomass combustion of forest and non-forest residuals are more than offset by the saved (avoided) decay emissions of CO2 and methane over time from those residuals. Further, fossil-fired power CO2 emissions are also avoided.

Sources of information for this analysis:

- Manomet June 2012 study
- National Renewable Energy Lab – Life Cycle Assessment of Biomass Co-firing in a coal-fired power plant – 2001
- International Governmental Panel on Climate Change – IPCC Fourth Assessment Report: Climate Change 2007
- Global Warming: The Significance of Methane, Bernard Laponte - 2008
- US Environmental Protection Agency – Draft Report of the Biogenic Carbon Emissions Panel – March 2012

Methodology used in this analysis:

- Carbon deficit and decay parameters from the April 2012 regulations
- Manomet June 2010 study assumptions for gas-fired and biomass power parameters
- NREL data used for methane emissions
- IPCC and Laponte report assumptions for methane impact multiplier

Note: The set of assumptions was made deliberately conservative in the aggregate.

Analytic conclusions:

- Per the DOER April 2012 regulations electric-only biomass will produce ***GHG benefits at least as great or greater than wind or solar within a 20-year time frame – increasing to more than twice that of wind and solar after 40 years***

  Note: The results of the 20-year life cycle analysis called for in the April 2012 regulations show that biomass power will provide net GHG benefits even without any avoided methane emissions benefits

- Use of biomass waste heat – while always desirable – is not technically required (1) to meet REC qualification requirements, or (2) to achieve GHG benefits at least as great as wind or solar

  Note 1: All-electric biomass, by itself, will meet the GHG qualification threshold (GHG impacts of less than ½ of gas-fired power impacts) of the April 2012 regulations, <u>even without fossil-fired power CO2 emissions displacement</u>

  Note 2: Use of biomass plant waste heat to supply thermal loads should be encouraged, but the *absence of a thermal load for the waste heat* should not be used to eliminate all-electric biomass, with its significant GHG reduction benefits

- The <u>cumulative</u> comparable GHG benefits – in million tons of reduced CO2-equivalent emissions – for biomass, wind, and solar facilities with 40-year plant lifetimes are:

	Biomass <u>101 MW</u>	Wind <u>261 MW</u>	Solar <u>609 MW</u>
Over 20 years:	10	9	9
Over 40 years:	35	17	17
Over 60 years:	51	17	17

  Note: After the 40-year facility lifetimes the benefits do not increase for wind and solar, but continue to increase for biomass because of the avoided decay emissions.

  Significantly, **the CO2-equivalent reductions from 101 MW of all-electric biomass by itself could achieve 2-3 percent of the GWSA 2050 goal of reducing annual CO2 emissions by 83 million tons.** This source of CO2 reduction could occur from just a few biomass plants. This is *<u>a major finding that calls for a change in state energy and global warming policy regarding biomass, particularly because the sustainable supply of residuals alone could support well over 100 MW of capacity, and could achieve over 5 percent of the 2050 goal</u>.*

To achieve the same CO2 reduction benefits as biomass over time the following MW capacities for wind and solar would be required:

	Biomass (MW)	Wind (MW)	Solar (MW)
Over 20 years:	101	316	737
Over 40 years:	101	539	1257
Over 60 years:	101	780	1819

Note: the above comparison is useful when comparing transmission line and facility construction requirements.

Implications and Actions

What should be understood about the analysis summarized in the section above is that the set of assumptions in the aggregate has been made deliberately conservative. As one critical example, the "49x" methane correction factor – which establishes the CO2-equivalent impact of methane – is an average 40-year correction factor, whereas the factor for a shorter time frame – e.g., 20 years – has been determined by the IPCC and others to be much higher. This would significantly increase the biomass GHG benefits in the first 20 years that are shown in the above section.

For biomass projects that can **provide positive GHG benefits by 2050** a renewable energy program change should be enacted that incorporates provisions for:

- Allowing a REC-qualification exemption from the project efficiency requirement for projects that can meet the GHG reduction REC-qualification threshold

- Creating a separate regulatory category for 15-20 year PPAs for at least 200 MW of biomass capacity, subject to available forest biomass and non-forest residuals in the fuel supply stream as certified by DOER. Note: Over 2 million tons per year of non-forest waste wood are generated annually in southern New England – enough to support 200 MW of biomass capacity. The amount of forest biomass would add to that.

  Note: The above PPA provision could readily fit into Bill S2214, Section 41, and would support the diversity objective reflected in that Section

Both of the above changes are needed if there is to be any biomass capacity constructed in Massachusetts, and if the 2050 GWSA goal is to be met. Otherwise, onshore wind projects (the least expensive renewable energy) will be awarded PPAs, and even they will further develop only if the mWh total required for distribution company PPAs is increased.

Although the analysis provided in this document (1) was based on the Manomet science already established and accepted by biomass opponents and (2) used decay parameters and a calculation methodology from the April 2012 regulations that are supported by biomass opponents, if there is still a question about the GHG benefits results, then a constructive legislative step would be to enact legislation that charges DOER with the requirement to carry out a forest and non-forest residuals sustainability and carbon policy study to be completed by December 2012. This would readily fit into Section 63 of Bill S2214 as an expansion of the DOER study called for in that Section.

Along with the major GHG benefits that are so critical to achievement of the GWSA goal the recommended regulations changes would produce several key ancillary benefits for every 100 MW of biomass capacity:

- Create an order of magnitude more permanent jobs than wind or solar (300 vs. 30 jobs)

  This benefit would strongly enhance the job-creation benefits already initiated by the Green Communities Act and Global Warming Solutions Act.

- Generate more tax revenues per year ($6 million per 100 MW vs. $1-2 million for wind and solar)

- Dispose of a major portion (over 1 million tons per year) of the state's unwanted waste wood, including periodic storm and fire damaged trees that continually constitute a removal problem for municipalities

The recommendations made at the beginning of this section regarding exempting the efficiency requirement and the provision of a PPA category for biomass overlap with broader policy considerations related to the GWSA. The 2050 CO2-reduction goal of 83 million tons per year could best be achieved if the time frame used to qualify biomass for RECs was greater than 20 years, or if the 20-year life cycle GHG impact threshold were made equal to that of gas-fired power (as opposed to one-half of it). The attachment on global warming policy discusses the rationale for this change.

Consideration of the above actions assumes a greater importance in light of the (1) growing and often vitriolic opposition to wind and solar in western Massachusetts that has already resulted in bans or moratoriums of these projects in some towns, and (2) recent wind-noise-related limitations under consideration by MA DEP. This trend, coupled with the continuing risk as to whether the needed Cape Wind project will obtain financing for a project with ¼ of its output not yet contracted for, raises key issues regarding achievement of the 2020 goals of the RPS program and the 2050 goal of the GWSA.

Another, broader energy trend relevant to renewable energy policy is the increase in low-cost gas-fired power in the generation mix. While the most favorable fossil power alternative, this will still increase GHG emissions, and will have a much lower job-creation impact per MW compared to biomass. In the Green Communities Act this will call for a stronger emphasis on GHG reduction

and job-creation power sources. For any given MW amount biomass power will easily provide the greatest contribution.

Special Note: Because of the profound policy implications of this analysis we have deliberately made the set of assumptions conservative in the aggregate, such that the debate will not be deflected to a discussion of whether the analysis is too optimistic or biased. Therefore, it is important to review the key assumptions and their likely conservatism. See the final attachment to this document.

ATTACHMENT - SOURCES OF NON-FOREST WASTE WOOD OR RESIDUALS

- Tree service companies (remove limbs from power lines, unwanted trees from residences and commercial properties). There are dozens of such companies.
- Land-clearing by builders of malls, houses, industrial properties, government facilities
- Storm-damaged trees
- Fire-damaged trees
- Diseased trees
- Stumps
- Sawmill residue – chips, bark and sawdust
- Municipal wood yards not co-located with any treated wood facility
- Clean construction wood waste
- Waste pallets

The above sources are listed in rough order of average annual volume.

ATTACHMENT - GLOBAL WARMING POLICY – TIME FRAME FOR CARBON POLICY GOALS

Biomass power presents a unique issue with regard to short-term and long-term CO2-reduction goals because in the first 5-10 years, depending on the fuel burned, biomass power results in a net increase in CO2 emissions, regardless of what long-term benefits occur. No other energy-related program or action presents this conundrum. The question is what time frame should be used to determine whether a proposed biomass project's short-term GHG impacts vs. long-term GHG benefits are acceptable. DOER has established a 20-year time frame within which a project must meet a minimum GHG benefits target (1/2 of gas-fired impacts for the same output). Our research has found no GHG policy in any country or US state that has any shorter time frame. Most of the major organizations addressing GHG policy focus on longer time frames – e.g., the Intergovernmental Panel on Climate Control (IPCC), which evaluates impacts out to 100 years.

There are enough research and study results to conclude that 2050 is a meaningful target year to achieve major GHG reductions. The GWSA appropriately sets out a demanding goal for this year. There are several factors relevant to GHG policy for biomass:

- Sufficient forest and non-forest biomass fuel is available in southern New England to support well over 100 MW (likely over 200 MW) of biomass power

- By 2050 100-200 MW of biomass power (just a few plants) would reduce annual CO2-equivalent emissions by 2-4 million tons per year – or 2.5-5 percent of the 2050 CO2-reduction goal.

- Beyond 20 years of operation a biomass plant produces a very significant increase in GHG benefits, such that biomass power would have as strong an impact in delaying a climate impact tipping point as any energy policy action

The GWSA policy question is whether 20 years is too short a time frame for a biomass plant burning eligible fuels under the April 2012 proposed regulations. Two actions are worth considering for biomass REC qualification such that desirable biomass is not prohibited:

1a Change the GHG impacts life cycle calculation to 30 years for the same life cycle impact requirement
OR

1b For a 20-year life cycle change the "50 percent lower than gas-fired" requirement to simply "lower than gas-fired" such that biomass will still be no worse than gas-fired in the short term and much more beneficial in the long term

AND

2 Exempt from the efficiency requirement any biomass plant that meets the GHG benefits 20-year life cycle benefits requirement

SUMMARY OF CONSERVATIVE ASSUMPTIONS - BIOMASS GHG BENEFITS ANALYSIS

REC-eligible forest and non-forest biomass fuels will support at least 100 MW of biomass	➢ Forest and non-forest wood waste estimates are over 2 million tons per year - enough for over 200 MW of biomass. Would double the biomass GHG benefit potential. Thinnings will add more.
Non-forest residuals limited to 50 percent of fuel mix, and is the only plant fuel methane emitter	➢ Biomass power plant could increase the non-forest fuel component, this increasing methane emissions benefits
For non-forest residuals used a 49x methane correction multiple. (Years 1-5 multiple is 101 and years 1-20 is 72 based on IPCC and other science)	➢ Would increase net biomass GHG benefits significantly in years 1-20 if best estimate multiple is used
No regrowth CO2 benefits assumed for tree thinnings	➢ Would increase biomass CO2 reduction benefits
Decay emissions long term (after year 60) are not counted, e.g.: -- For power year 1 this excluded 2% of emissions -- For power year 40 excluded 25% of emissions	➢ Would increase long-term biomass benefits compared to wind and solar
Assumed 40-year biomass plant life (typically will be longer)	➢ A longer biomass plant life would increase the long-term biomass benefits to more than 3x wind or solar
No CHP benefit included in cumulative summary table	➢ Understates the total GHG-reduction potential but is not included because it is not needed for REC GHG benefits qualification
Used a gas-fired power GHG emissions displacement whereas some oil and coal would be displaced as well in ISO New England	➢ Understates fossil power displacement benefits
Ignored CO2 reduction in plant exhaust from any greenhouse application	➢ Would slightly improve biomass benefits